HEC-DSS Vue
HEC Data Storage System Visual Utility Engine

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Abstract: The U.S. Army Corps of Engineers Hydrologic Engineering Center has developed and released HEC-DSS Vue (Visual Utility Engine), a graphical user interface for the HEC Data Storage System. HEC-DSS Vue allows users to plot, tabulate, edit and manipulate data in HEC-DSS database files. It effectively supercedes the HEC-DSS DSSUTL, DSSMATH, and DSPLAY utility programs.

The main display of HEC-DSS Vue lists the contents of a DSS file as a sorted and filtered catalog of data set names (pathnames) and allows the user to select individual data sets for display or manipulation with a mouse click. The graphics produced by HEC-DSS Vue are highly customizable and can be saved in several formats, including "jpeg" and "png" (portable network graphics), and can be printed or copied to the system clipboard for inclusion in reports. HEC-DSS Vue allows users to enter data into HEC-DSS database files, and to rename, delete, and copy data sets to other DSS files. HEC-DSS Vue incorporates all the mathematical functions—more than 50—that were available in the DSSMATH program.

Routine sequences of steps can be programmed in HEC-DSS Vue with the "Jython" scripting language, and executed from user-defined buttons or from "batch" processes. HEC-DSS Vue was written using the Java programming language, which allows it to run under a variety of operating systems. Fully supported systems include Microsoft Windows 98 / ME / NT / 2000 / XP, and Sun Solaris (Unix).

INTRODUCTION

Overview of HEC-DSS: The HEC Data Storage System, or HEC-DSS (not to be confused with a Decision Support System), is a database system designed to efficiently store and retrieve scientific data that is typically sequential. Such data includes, but is not limited to, time-series data, curve data, spatial-oriented gridded data, textual data, and others. The system was designed to make it easy for users and application programs to retrieve and store data.

HEC-DSS originated in 1978 in order for hydrologic modeling programs to exchange time-series data. The original version was written for programs using the Fortran and "C" programming languages. Over time, it has migrated to include programming

interfaces for C++, Visual Basic and Java. HEC hydrologic and hydraulic modeling programs, including HEC-RAS, HEC-HMS, HEC-ResSim, as well as a variety of others past and present, are interfaced with HEC-DSS. A assortment of utility programs have been developed to 1) load and import data from a range of formats; 2) export data; 3) graph, tabulate and edit data; 4) mathematically manipulate data; and 5) perform various database utility and maintenance functions. Several of these functions have been incorporated into HEC-DSS Vue, a graphical user interface program for HEC-DSS.

HEC-DSS has been installed on a variety of operating systems including Microsoft Windows, Apple Macintosh and a variety of Unix flavors. There are no licenses or fees required for HEC-DSS or its utilities; the software is in the public domain and can be obtained free of charge from the HEC web site at http://www.hec.usace.army.mil.

HEC-DSS Use: The HEC-DSS is generally considered to be a "model-oriented" or a "working" database system. Currently it is used extensively in Corps offices for both project studies and real time water control and reservoir operations, such as in the Corps Water Management System or CWMS (HEC, 2003a). Data for CWMS (such as precipitation and stream flow values) are typically received from field collection platforms via satellite and stored in a corporate database. When a CWMS modeling run is to be executed, data is extracted into a subset HEC-DSS file for that run. HEC-HMS, a rainfall-runoff model, uses gridded precipitation data from radar or gage readings, along with observed flows and estimated future rainfall, to compute forecasted flows. The forecasted flows are utilized by HEC-ResSim, a reservoir operations model, to simulate reservoir operations and compute regulated flows. River stages and inundation maps are then computed by HEC-RAS, a river hydraulics modeling program. HEC-FIA, an economic benefits / flood impact model, uses this information to compute damages and project benefits. HEC-DSS is used to exchange the various data sets between the modeling programs.

HEC-DSS Characteristics: HEC-DSS incorporates a modified hashing algorithm and hierarchical design for database accesses that is designed specifically for the storage and retrieval of large sets of data. This includes (but is not limited to) computed or observed daily flow values, hourly precipitation amounts, rating tables, and radar rainfall measurements. HEC-DSS is not optimized for dealing with small data sets or single data values, nor is it effective at conditional data searches common to relational database systems. In contrast, most commercial databases are designed for smaller sets of data, or elements. Such elemental data includes employee records, accounting data, and inventory of stock.

Data in HEC-DSS is stored in blocks, or records, and each record is identified by a unique name called a "pathname".   A record's pathname must be given each time that its data is stored or retrieved from a HEC-DSS file. A pathname consists of six parts, which describe the data, including its region, location, parameter, beginning time and version. This convention makes the data set self-documenting. An example pathname for observed hourly time-series flow data is:

/SACRAMENTO RIVER/RED BLUFF/FLOW/01MAR1995/1HOUR/OBSERVED/

The block of data for this pathname would consist of a month of hourly values, in this case 744. Although individual data sets are stored in time-oriented blocks, modeling and utility programs simply use a start and end date and time to identify a data sequence. Stored along with the data is other descriptive information, such as the units and type (e.g., instantaneous or average), and an optional set of flags that describe each data value's quality or validation.

Because of the self-documenting nature of the pathname and the conventions adopted, there is no need for a data dictionary or data definition file as required with other database systems. In fact, there are no database creation tasks or any database setup. By just providing a HEC-DSS file name to an application or utility program, a HEC-DSS database file will automatically be generated and configured. There is no pre-allocation of file space; the software expands the file size as needed.

HEC-DSS VUE

Summary: HEC-DSS Vue is a Java-based visual utilities program for users to plot, tabulate, edit and manipulate data in HEC-DSS database files (HEC, 2003b). It is fully supported on computers running Sun Solaris and Microsoft Windows. HEC-DSS Vue can be run as a client-server program through the CWMS framework, where the user typically runs it on a Microsoft Windows PC and accesses data in a HEC-DSS file on a Sun server. The Microsoft Windows version of the program, and supporting documentation, can be downloaded for free from the HEC web site at http://www.hec.usace.army.mil.

The graphics produced by HEC-DSS Vue are highly customizable and can be saved in various formats, including "jpeg" and "png" (portable network graphics), or printed or copied to the system clipboard. HEC-DSS Vue incorporates over fifty mathematical functions, including those that were available in the DSSMATH program. HEC-DSS Vue also has several utility functions for entering data, renaming record pathnames, copying data to other HEC-DSS files, as well as a variety of other functions.

Main Screen: The main screen of HEC-DSS Vue provides a sorted, filtered list of pathnames to select data sets from, as show in Figure 1. The HEC-DSS file to access is opened either by typing in the name in the File Name box, or by selecting the file from the "Open" dialog. The pathnames from the file are displayed as either a list of individual pathnames, a list of pathnames broken into their six parts, or a pathname part list where time-series data start and end dates are shown. Pathnames can be filtered in the list by selecting parts from pull-down boxes, giving the user the capability of quickly selecting the category of data he or she is interested in. By clicking on a part column header, the pathnames will be sorted alphabetically by their parts. Data sets to view or manipulate are chosen by selecting the rows with their pathnames, then pressing the "Select" button. Selected pathnames are displayed in the lower panel of the screen. Once data sets are selected, the user can plot, tabulate, edit or manipulate the data by choosing the appropriate function from the menu bar or tool bar.
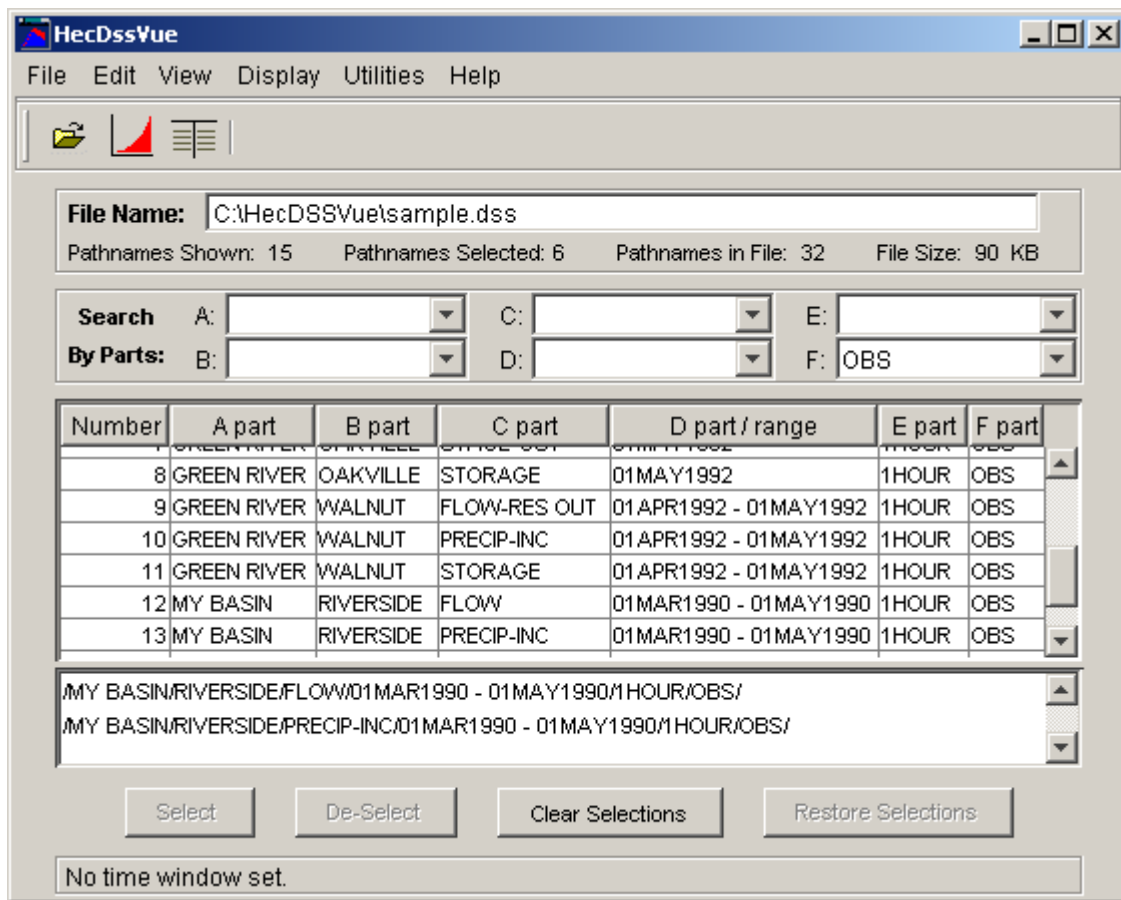
Figure 1 - HEC-DSS Vue Main Screen

Plots: An example HEC-DSS Vue plot is shown in Figure 2. On the left side of the plot window are pointer and zoom mouse tools, which change the functionality of the mouse when selected. When the pointer tool is selected, and the mouse is positioned over a point on a curve, a tool tip (a small text box adjacent to the mouse position) containing the value and date and time of the data at that point will be displayed. Right clicking on the curve with the pointer tool will bring up the curve's properties editor, which is used to change such things as the color, style and weight of the curve. When the zoom tool is selected, the user can zoom in on portions of the plot by left-clicking the mouse at one point, dragging it to another location, then letting go. Scroll bars will appear in the window allowing the user to scroll through different parts of the enlarged graph.

From the plot' File menu, a user can print the plot, copy it to the clipboard, or save it in a graphics format file such as jpeg or portable network graphics. The "Plot Properties Editor", selected through the Edit menu, provides for customizing the plot appearance. This includes setting the title, legend, viewport size, background, curve colors, weights and styles, and the axes. Users can add "callouts", which are text boxes that point to specific locations on the graph (such as "Peak of 63,000" in Figure 2), and "marker lines", which identify a constant X or Y value (such as the "Flood Stage" line in Figure 2). Attributes in the Plot Properties Editor are categorized in a note-tab fashion, as depicted in Figure 3. Typically, selecting buttons or items from drop-down lists in the

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editor sets the properties. Once set, the plot attributes can be saved as a "template". A template is essentially a file with a list of the changes made to the plot, which can be used in subsequent plots with the same or similar data sets.
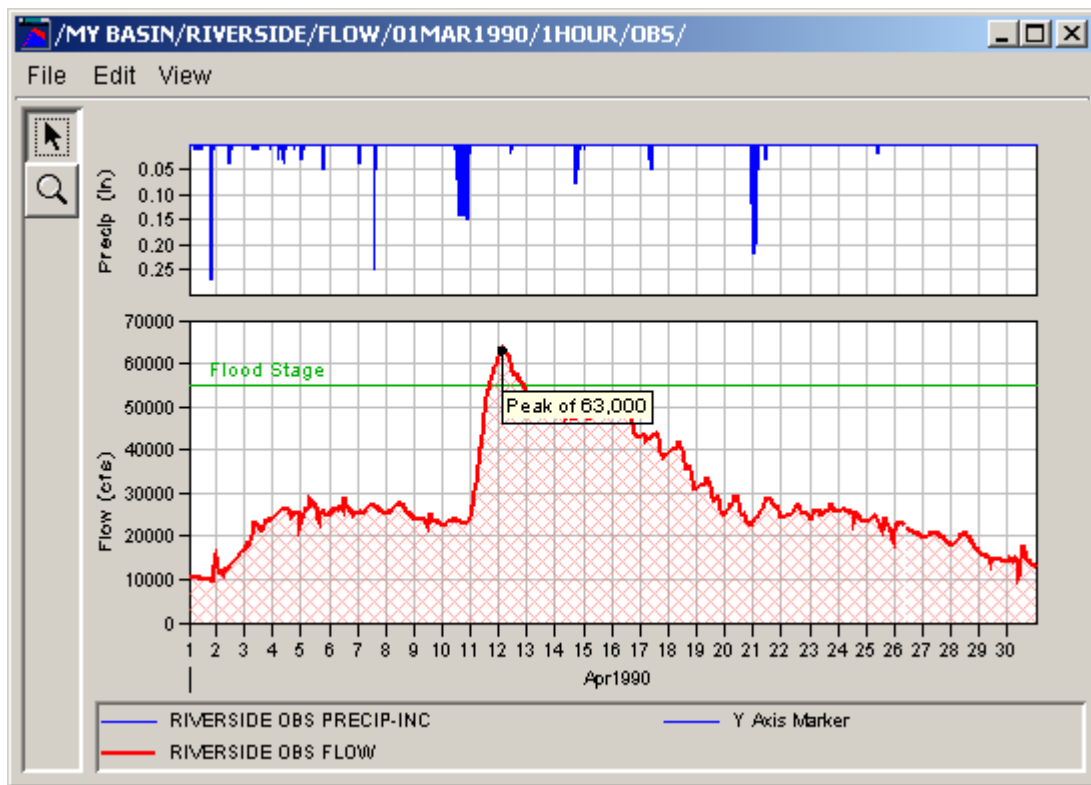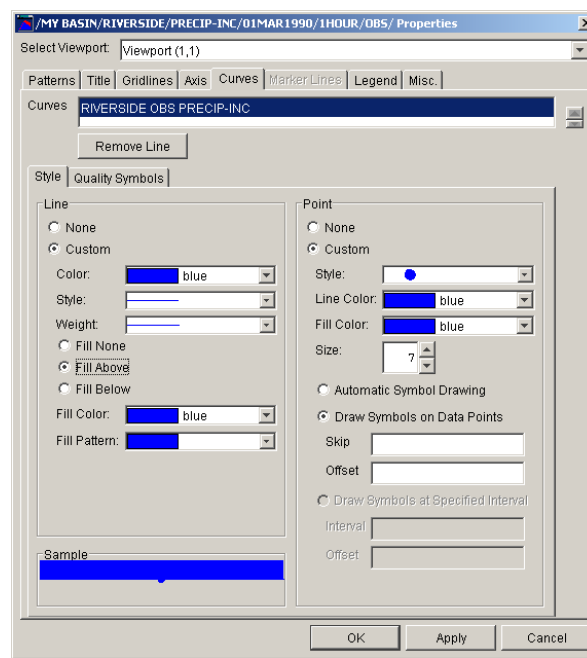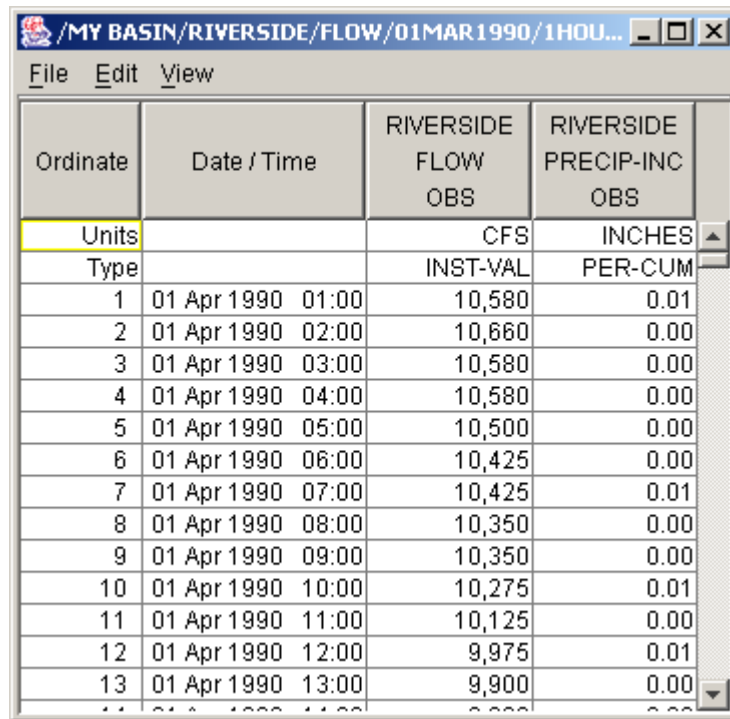

Figure 2 - Example Plot

Figure 3 - Plot Properties Editor

Tabulation and Editing: An example tabulation window is depicted in Figure 4. Data is tabulated in a columnar fashion with the date and time preceding values in each row for time-series data. A vertical scroll bar, positioned on the right-hand side of the screen, can be used to scroll up and down through the table. The table, or selected rows and columns, can be printed from the "Print" menu item, or exported to an ASCII delimited file from the "Export" menu item, both available from the File menu.

Ordinate	Date / Time	RIVERSIDE FLOW OBS	RIVERSIDE PRECIP-INC OBS
Units		CFS	INCHES
Type		INST-VAL	PER-CUM
1	01 Apr 1990 01:00	10,580	0.01
2	01 Apr 1990 02:00	10,660	0.00
3	01 Apr 1990 03:00	10,580	0.00
4	01 Apr 1990 04:00	10,580	0.00
5	01 Apr 1990 05:00	10,500	0.00
6	01 Apr 1990 06:00	10,425	0.00
7	01 Apr 1990 07:00	10,425	0.01
8	01 Apr 1990 08:00	10,350	0.00
9	01 Apr 1990 09:00	10,350	0.00
10	01 Apr 1990 10:00	10,275	0.01
11	01 Apr 1990 11:00	10,125	0.00
12	01 Apr 1990 12:00	9,975	0.01
13	01 Apr 1990 13:00	9,900	0.00

Figure 4 - Example Table

Data in the table is edited by choosing "Allow Editing" from the edit menu. Individual values are changed by selecting a cell and typing in a new number. Multiple cells within a column can be set to a constant or interpolated values by selecting the cells, right-clicking the mouse and picking the "Fill" option from the shortcut menu. Data can be pasted into the table from the system clipboard by selecting the beginning cell and choosing the "Paste" menu item (or control-V). Selected cells are copied to the clipboard with the "Copy" menu item (or control-C).

Data Entry: Data is entered into a HEC-DSS file by means of a table in the "Manual Data Entry" screen, as depicted in Figure 5. This screen provides an area to enter the pathname, units, start date and time, along with a blank table to enter values in. Frequently this screen is used to copy data into HEC-DSS from another Windows application, by copying the data into the clipboard from that application and pasting it into the table. A user can also generate a given number of constant values from an option on this screen.

Figure 5 – Manual Data Entry

Math Functions: HEC-DSS Vue has over fifty mathematical functions for manipulating data, including all of the functions that were originally in the DSSMATH program (HEC, 1995). The "Math Functions" screen subdivides these functions into six categories accessible from note-tabs, as illustrated in Figure 6. Arithmetic operations, such as add, subtract, multiply and divide of a constant or another data set, trigonometry and logarithmic functions, accumulation and difference calculations are accessible from the "Arithmetic" tab. Functions in the "General" tab include unit conversion, estimation of missing values, and rounding and truncation of data values. For time-series data, the "Time Conversion" tab provides a means of transforming data to regular interval or irregular interval, changing the time interval, shifting data in time and other options. Hydrologic computations include a variety of routing algorithms, rating table lookups, conic interpolation and the calculation of regression coefficients from multiple linear regression analysis. Smoothing algorithms and several statistic calculations can also be computed from the Math Functions window. The resultant data can be plotted or tabulated along with the original data prior to being saved, if desired.

Utility Functions: HEC-DSS Vue has several database utility and maintenance functions. These include renaming pathname records, duplicating records and copying records to other or new HEC-DSS files. The Rename and Duplicate functions are based on changing one or more pathname parts for the selected records. Other utility functions include Merge, which will combine all of the records in one HEC-DSS file into another, and Squeeze, which removes inactive space caused by deleting records and rebuilds the file's index tables.
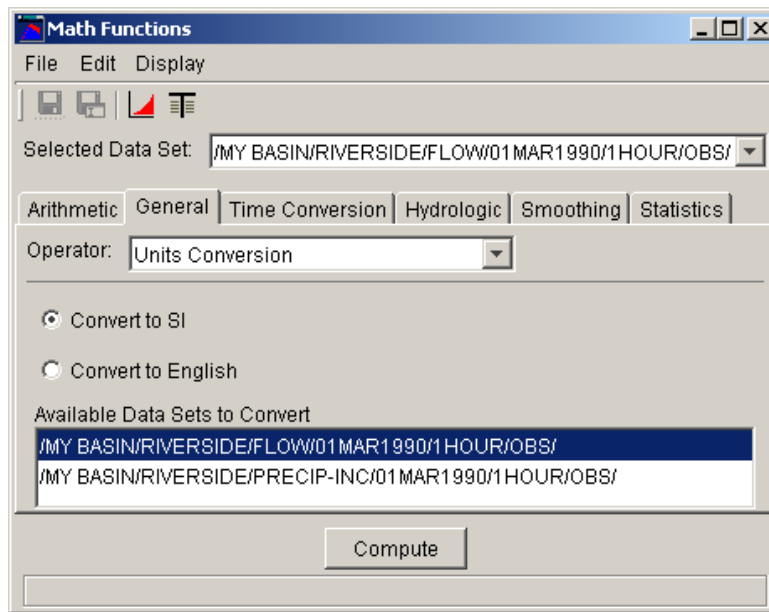
Figure 6 - Math Functions Dialog

Scripting: HEC-DSS Vue incorporates the Jython scripting language to perform sequences of operations in an automated fashion. An example use of a script is to plot current data with the desired options, then save the resultant plot in a jpeg file for use on a web page. Jython is a standard scripting language that is an implementation of the Python programming language designed specifically for integration with Java. Scripts may be executed in batch mode by starting HEC-DSS Vue with the script file name as a program argument. Scripts may be run interactively from the "Script Selector Dialog", which is a window with a button for each script, or from the "Script Browser". The Script Browser, as depicted in Figure 7, provides a means to create new scripts, edit scripts, and import scripts from other users or applications. A script shortcut icon button can be placed on the main toolbar from the browser.

Jython scripts are a series of object-oriented commands loosely based on Java. They are simple enough that non-programmers can construct them with relative ease, but powerful enough to give experienced users full access to all of the functions and capabilities in HEC-DSS Vue. An example script to open a HEC-DSS file and tabulate a data set is in the Script Browser in Figure 7. A further description of scripting and the list of scripting functions available (the API or Application Program Interface) are given in the HEC-DSS Vue User's Manual (HEC, 2003b).

Future Enhancements: Planned future enhancements of HEC-DSS Vue, which are dependent on funding, include a graphical edit capability; import and export of data to ASCII delimited files and the system clipboard; and a client-server version that is removed from the CWMS framework. The graphical editor will be a modification of the CWMS Validation Editor, as depicted in Figure 8. This editor has a combination of a plot and table together in the same window. The green hatch pattern in the plot corresponds to the data that is currently displayed in the table. As the table's vertical scrollbar is moved, the green hatch pattern on the plot moves concurrently. Several data

sets can be edited on the screen at the same time. To select which data set to edit, the user clicks on the column header of that data set in the table portion. Mouse tools on the left-hand side allow data to be edited as point values or from lines drawn with the mouse. As data is modified in the plot, those changes are reflected in the table. Conversely, data changed in the table is immediately reflected in the plot.
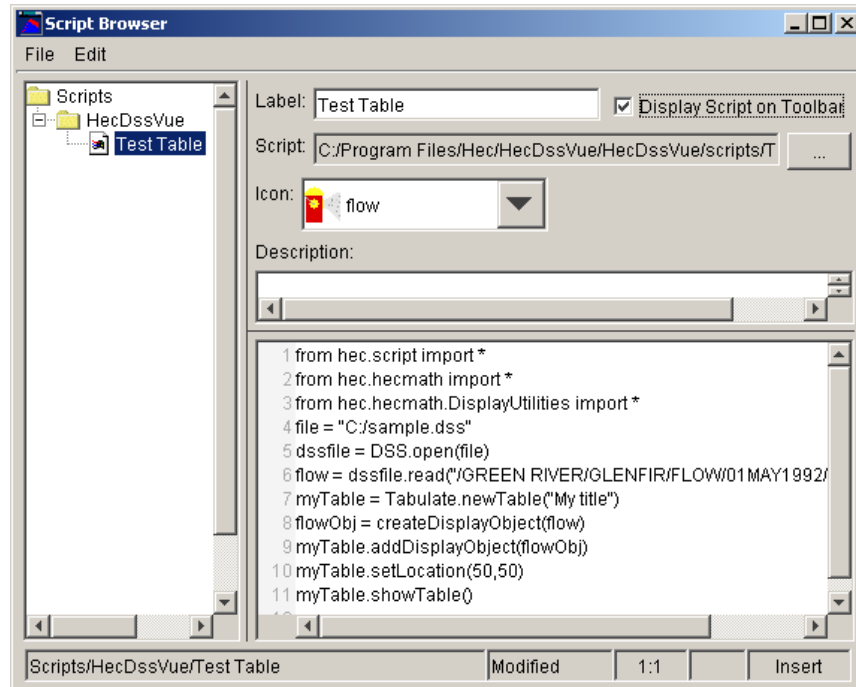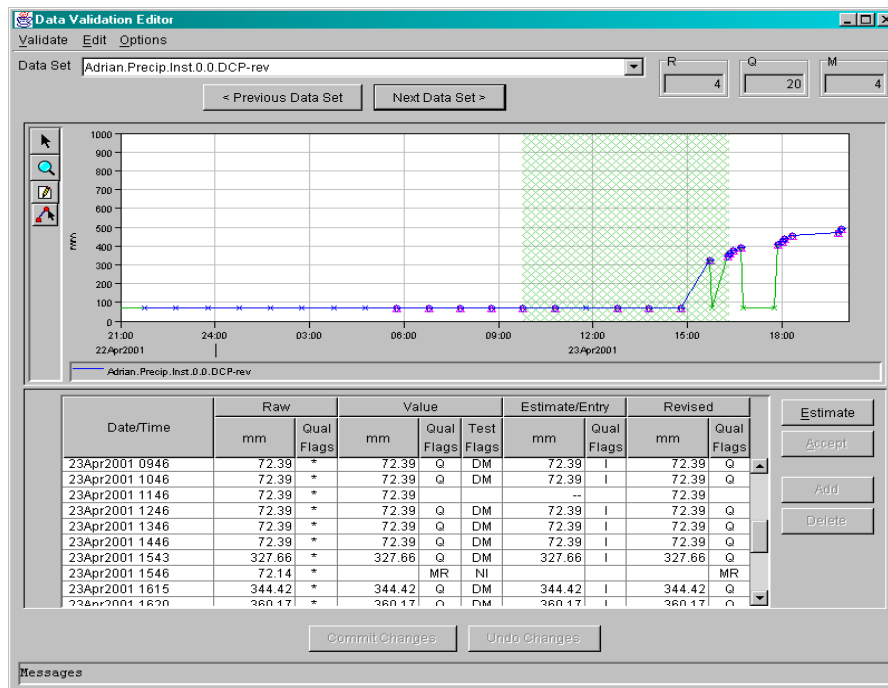

Figure 7 - Script Browser

Figure 8 - CWMS Validation Graphical Editor

CONCLUSIONS

HEC-DSS provides an efficient database for storing and retrieving serial data for application and utility programs. It has been incorporated into the current hydrologic and hydraulic modeling programs developed by HEC, as well as programs developed by other organizations. HEC-DSS Vue is a Java-based graphical user interface program for graphing, tabulating, editing and manipulating HEC-DSS data. It is supported on Sun Solaris and Microsoft Windows platforms. It may be obtained free of charge for the Windows environment from the HEC web site at: http://www.hec.usace.army.mil.

REFERENCES

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